A 9-month-old previously healthy girl was brought to our Pediatric Emergency Department and admitted with acute respiratory distress, stridor and hoarseness. She had a four-day history of high-grade fever, cough and rhinorrhea. She had been taken to a clinic where croup was diagnosed. There was no difficulty in swallowing, however, there was no response to medical therapy for viral croup. At our emergency department, a chest X-ray (Figure 1) only showed mild perihilar infiltration and no other active lung lesions. Leukocytosis (white blood cell: 24700/mm³) and bandemia (band form: 21.0%) with a high level of C-reactive protein (275.6mg/L) were noted on laboratory tests. Neck computed tomography (CT) was performed to exclude a retropharyngeal abscess and foreign body aspiration, as emergency flexible bronchoscopy was not available at that time. No abnormal findings were reported on the neck CT initially (Figure 2A). She subsequently received endotracheal tube intubation for progressive respiratory distress and cyanosis. Flexible bronchoscopy was then performed and showed necrotic debris and mucopurulent secretions in the tracheal lumen (Figure 3). After reviewing the neck CT, a sludgy shadow
was noted in the tracheal lumen on the lung window (Figure 2B). Antibiotic treatment with Vancomycin and Ceftazidime showed a good response. The patient was extubated within 48 hours and did well without residual stridor. No fever and smooth respiration with fair saturation under room air conditions were noted. A culture of the tracheal necrotic debris revealed *Pseudomonas aeruginosa*. She completed a 10-day course of intravenous Vancomycin and Ceftazidime treatment, and was then discharged from the hospital without any neurological or pulmonary sequelae.

**DISCUSSION**

Bacterial tracheitis, also called bacterial croup or bacterial laryngotracheobronchitis, is a term that was first reported by Jones et al. in 1979.\(^3\) It is an invasive exudative bacterial infection of the soft tissues of the trachea, and generally occurs during the first six years of life. It often occurs after prior airway mucosal damage, such as during a preceding viral infection. Several authors have suggested that bacterial tracheitis is a complication of viral upper respiratory tract infection.\(^4,5\) Aspiration of bacteria-laden secretions into the trachea during bacterial infections of the upper respiratory tract (e.g. acute bacterial sinusitis, streptococcal pharyngitis) or after tonsillectomy may also lead to bacterial tracheitis.\(^5,7\) There is often a mixed infection, and both aerobic and anaerobic bacteria may be involved.\(^5\) *Staphylococcus aureus* is the most common bacterial isolate, followed by *Haemophilus influenzae* type b.\(^4,5,8,9\) However, in Taiwan, Huang et al. found that the most frequently isolated bacteria from patients with bacterial tracheitis were *α*-hemolytic *Streptococcus*, followed by *Pseudomonas* and *Staphylococcus aureus*.\(^10\) *Pseudomonas* infection often leads to more complications and a longer hospital stay.\(^11\) Viruses that have been isolated in children with bacterial tracheitis include influenza A, influenza B, respiratory syncytial
virus and parainfluenza virus. Influenza A appears to be the most commonly associated viral infection. Two type of presentations of bacterial tracheitis (primary and secondary) have been described in children. In primary bacterial tracheitis, the onset is fulminant, with progression to acute respiratory distress less than 24 hours after the onset of initially minor symptoms. Most children with fulminant onset appear toxic, with fever and leukocytosis at the time of presentation. In secondary bacterial tracheitis, prodromal symptoms and signs suggesting a viral respiratory tract infection are present for one to three days before more severe signs of illness, such as stridor and dyspnea. The incidence of secondary bacterial tracheitis is much higher than that of primary bacterial tracheitis. In general, the predominant clinical features of bacterial tracheitis are stridor, cough, fever, toxic appearance and failure to respond to the usual croup therapy such as nebulized racemic epinephrine and systemic steroids. Abundant purulent secretion from the trachea is evident in all patients with bacterial tracheitis, and because of this purulent secretion, a large number of patients develop pneumonia as a complication. The opportunity for the development of systemic complications such as septic shock and acute respiratory distress syndrome is present in bacterial tracheitis. One study reported that 13 of 118 patients had severe cardiopulmonary failure, four of whom died.

A definitive diagnosis of bacterial tracheitis requires direct visualization of an inflamed and exudate-covered trachea via endoscopy including direct laryngoscopy and/or flexible bronchoscopy. Modified clinical diagnostic criteria of bacterial tracheitis were proposed by Oymar, according to which the patient must have the clinical signs of upper airway obstruction, and in addition at least two of the following three criteria: 1) radiographic signs of intra-tracheal membranes; 2) laryngotracheal inflammation and mucopurulent secretion by direct visualization; and 3) growth of pathogenic bacteria or leukocytes on gram stains in the aspirate from the trachea. Imaging is required in both anterior to posterior (the AP) and lateral view of the neck, and the findings can be linear filling defects, irregular tracheal wall, membranes or asymmetric narrowing of the subglottic area. In our case, the neck lateral view was not available as the patient was unable to co-operate. Neck CT showed negative findings initially, however mucopurulent secretion was confirmed on the “lung window” setting. Laboratory studies other than tracheal cultures are of limited value in the diagnosis of bacterial tracheitis.

The major treatments for bacterial tracheitis are maintenance of the airway and administration of appropriate antimicrobial agents. Some children require emergent or urgent evaluation of the airway via flexible bronchoscopy. Children with bacterial tracheitis should generally be admitted to a pediatric intensive care unit even if endotracheal intubation is not required, so they can be monitored for potential disease progression. Once the diagnosis is suspected, the patient should be given broad spectrum antibiotics intravenously. Empiric antimicrobial therapy includes an antistaphylococcal agent (e.g. vancomycin or clindamycin) plus a third-generation cephalosporin (e.g. cefotaxime or ceftriaxone) or ampicillin-sulbactam for 10 days. If treatment is initiated early with antibiotics, the prognosis is good. In a multicenter retrospective case series, 30 of 34 patients received glucocorticoids such as dexamethasone. The use of glucocorticoids in the initial management does not seem to influence the overall outcome. However, glucocorticoids are not recommended as the initial management for children with bacterial tracheitis. It is important to implement a high degree of monitoring to be able to treat systemic complications early. The complications of bacterial tracheitis include acute upper airway obstruction, respiratory arrest, pulmonary edema and pneumonia. Toxic shock syndrome and acute respiratory distress syndrome have been documented secondary to staphylococcal tracheitis. Frequent suction from the trachea to remove toxins and toxin producing organisms is also important.

In conclusion, bacterial tracheitis remains a life-threatening upper-airway infection. Prompt recognition and accurate diagnosis can lead to decreased mortality. It is essential to reassess cases of croup whose outcome is not rapidly favorable. Such patients should be monitored in a pediatric intensive care unit, and flexible bronchoscopy should be used to diagnose and guide specific therapy to decrease morbidity and mortality.
Figure 2A. Neck CT sagittal soft-tissue window setting.

Figure 2B. Lung window setting showed a sludgy shadow in the tracheal lumen (arrows).

Figure 3. Flexible bronchoscopy showed necrotic debris and mucopurulent secretions in the tracheal lumen.
REFERENCES